L1b/L1c and RTA Planning for V6

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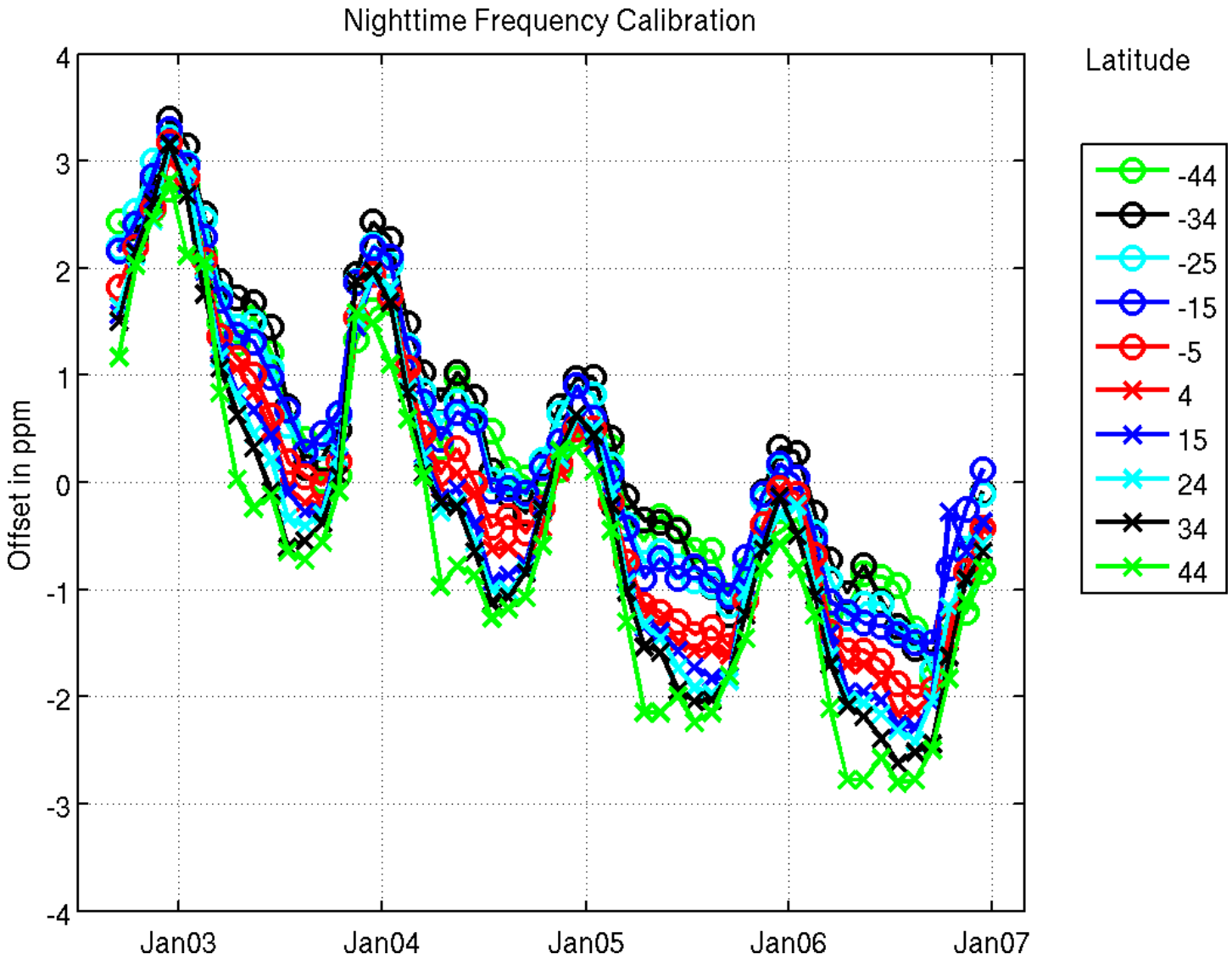
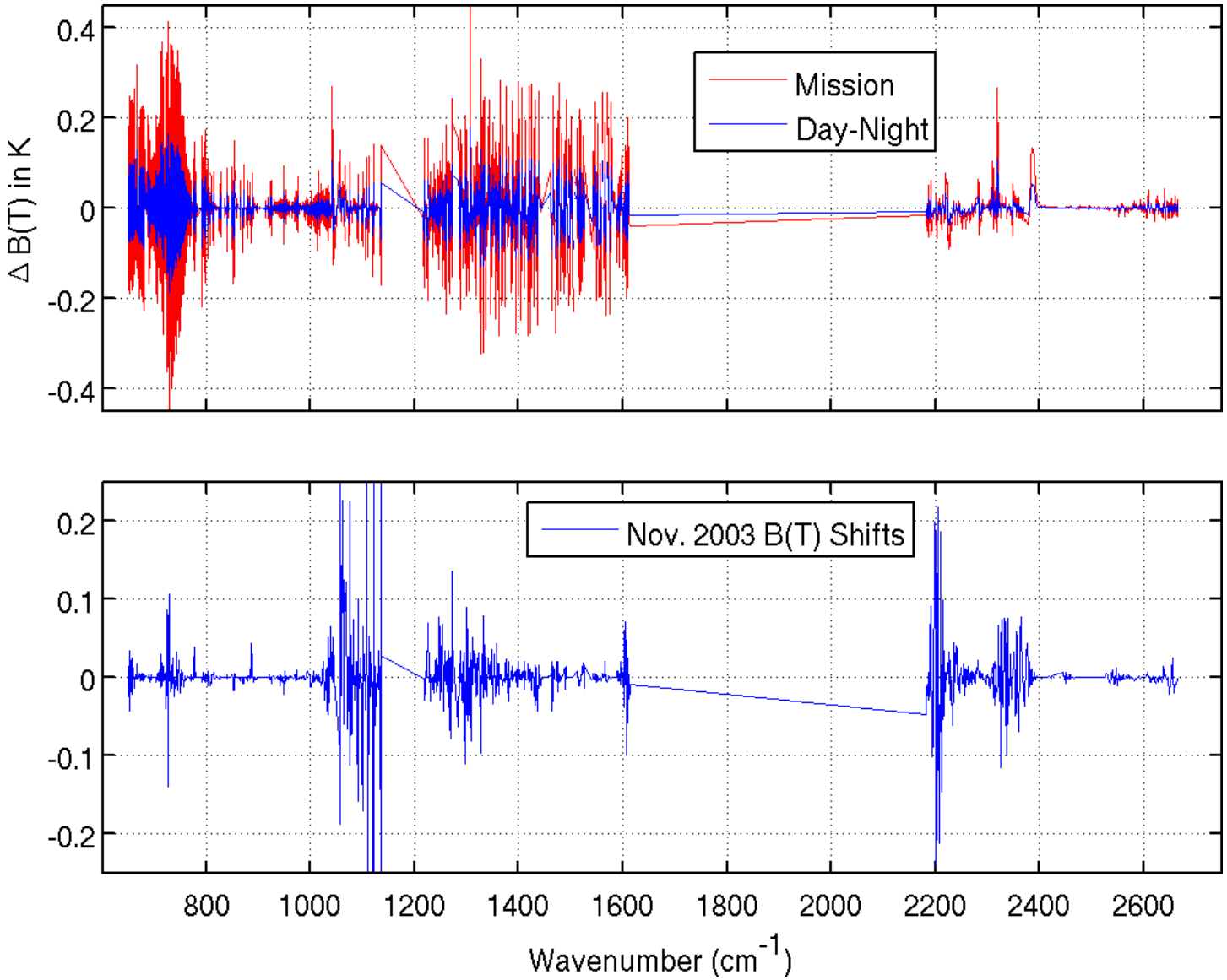
L1b Frequency Calibration

1. Improve AIRS frequencies as provided in existing L1b.
2. Existing frequencies are (1) Static set for Planck calculations, (2) noisy set (see following graph) of per granule frequencies
3. Goal: climate quality accuracies, <0.01K/year equivalent B(T) error.
4. Existing frequency variation of AIRS in B(T) units: ± 0.1K day vs night, almost ± 0.4K over life-of-mission (see following graph).
5. Frequencies vary with orbit (latitude) with superimposed slower drift. (See following graph.)

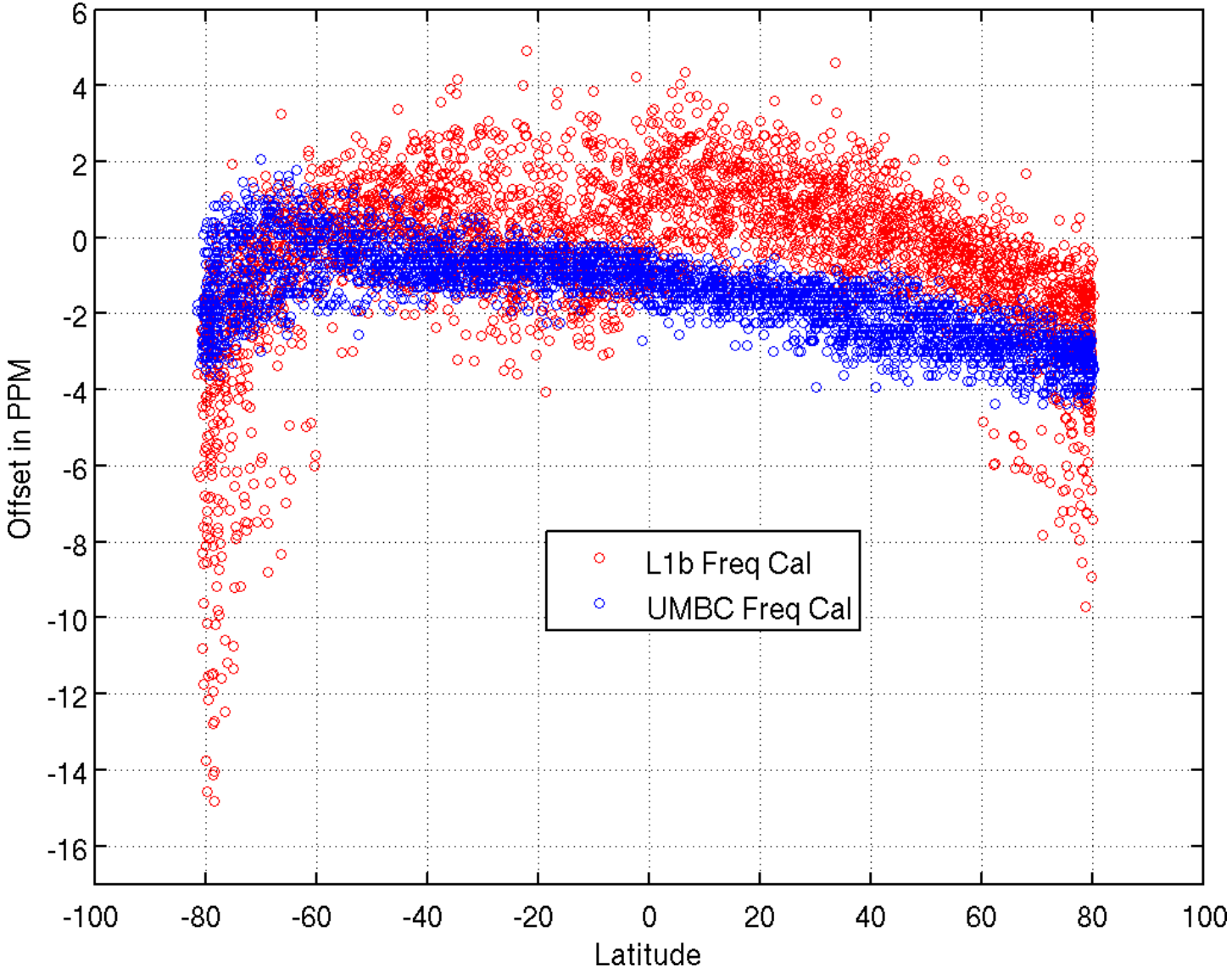
Variation of AIRS Frequencies with Time: 4 Years



Frequency Drifts and Fringe Shifts in B(T) Units



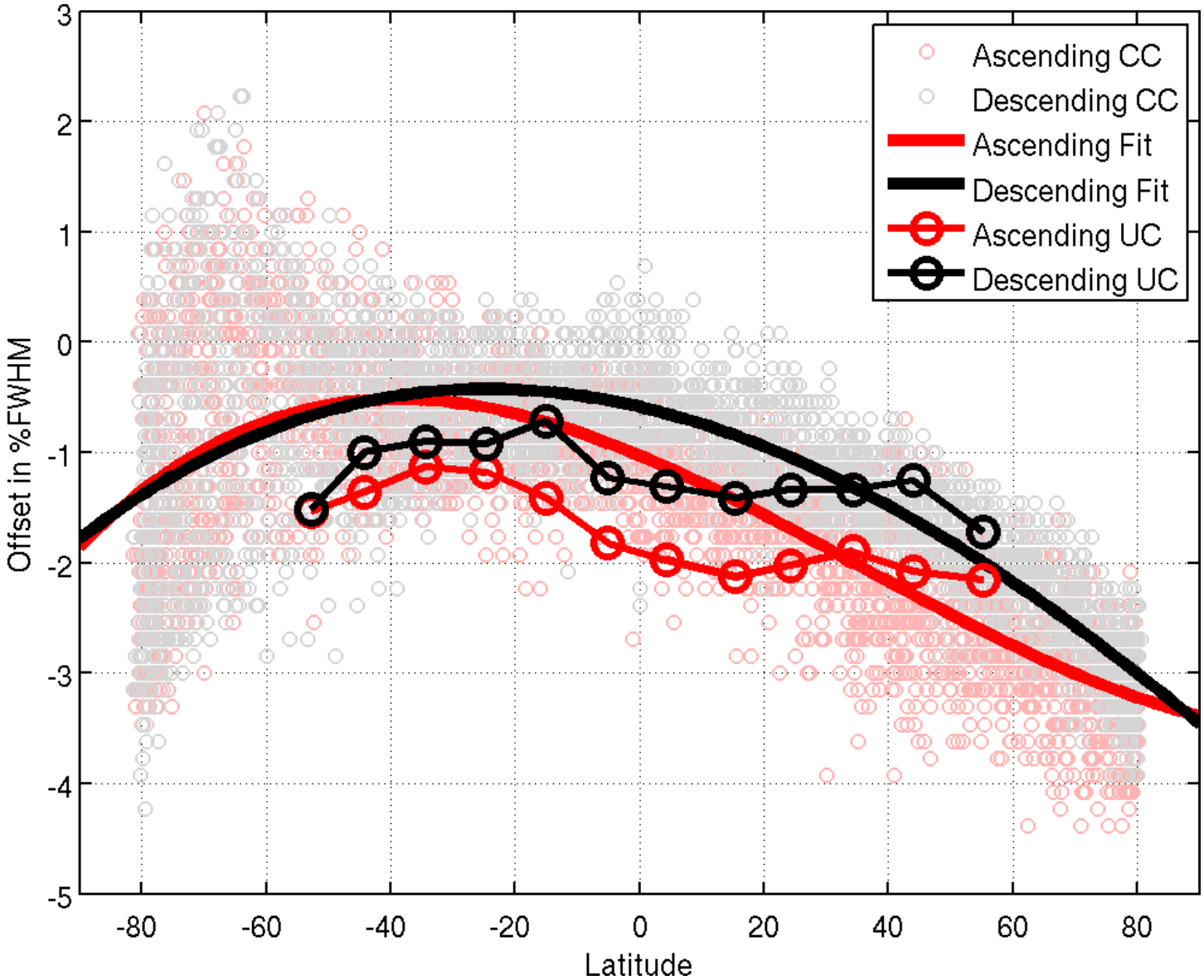
UMBC versus L1b Frequencies (1 month)



Approach

- Determine frequency shifts off-line using V5 data.
- Presently using UMBC's uniform_clear data set, limited to $\sim \pm 50$ degrees latitude. Use cross-correlation to clear FOV B(T)'s computed from ECMWF.
- Some work to extend to higher latitudes using CC'd radiances. More work needed to solidify this approach.
- Results easily parameterized, will provide a function that computes the frequency as a function of latitude and time.
- This approach doesn't quite fit with a granule average frequency list since latitudes vary.

UMBC Frequency Fits using CC'd and ACDS-like Data



L1c Frequency-Corrected Radiances

- As per previous slides, radiance errors of ± 0.4 K possible during life of mission if radiances not corrected for frequency drifts.
- Knowledge of frequencies proposed to be in L1b product.
- L1c radiance product would shift L1b radiances to uniform spectral scale.
- $R_{L1c} = R_{L1b} + dR/d\nu \times d\nu$. $d\nu$ is in the L1b product. $dR/d\nu$ will come from RTA calculation.
- Fairly mature for *clear* scenes. Not tested for cloudy scenes.
- Assume future users of AIRS radiances for climate studies will use this product.
- Use this opportunity to "fill in" missing channels. Test with IASI.

L1c Approach

- Use ECMWF or previous version AIRS retrieval to compute $dR/d\nu$ for a given atmospheric state.
- Tested (and used) for UMBC CO_2 retrievals, clear scenes only. Used ECMWF for atmospheric state.
- UMBC cloudy RTA should allow $dR/d\nu$ to be computed using AIRS cloud retrievals. Untested.
- Issues with poor retrievals or non-existent retrievals. Could use a spectrum matching algorithm to get $dR/d\nu$.
- Depends on cloudy RTA in system (gray clouds).

V6 Clear RTA: Goals

- Spectroscopy improvements:
  - Analyze remaining AIRS validation data to improve spectroscopy (ARM launches and ECMWF (for consistency)).
  - Ingest latest HITRAN database (O3, HNO3).
  - Validate upper atmospheric CO2 with COSMIC GPS? This might provide the only validation of our upper-air spectroscopy.
  - Use zonal CO_2 seasonal climatology?
  - See if AIRS and IASI need same type of spectroscopy changes.
  - CH_4 consistency? (OPTRAN vs PFASST)
  - Add variable CCl_4?
- Above testing requires
  - Two RTA's (pre- and post-Nov. 2003 fringe shift).
  - CO_2 model (in-hand)
  - Frequency shift model
  - Test with IASI to separate spectroscopy from instrument issues

V6 Clear RTA: Approach

- Fringe shifts in Nov. 2003 will require two RTA coefficient tables.
- *If* L2 will use true frequencies, RTA will also need two sets of coefficient tables to interpolate between, and associated code.
  - Use L1b $d\nu$, and intermediate atmospheric state to compute $dR/d\nu$, and then adjust CC'd radiances with multiplication of these two terms.
  - Unclear if this is necessary. Need to look at particular channels used in retrievals to determine need.

V6 Scattering RTA

- Dust (and cirrus?) retrievals should be possible using a scattering RTA.
- UMBC has developed a scattering RTA that is very fast and relatively easy to implement. Limitation in shortwave. Would like to evaluate using Ping Yang/Baum scattering model for consistency.
- Several versions exist
  - Two gray clouds: this version mimics the existing AIRS cloud products and can be used for closure experiments.
  - Two scattering cloud layers: we suggest this version for retrievals. Scattering parameters can be for dust, ice particles, water droplets. Any combination of two of these is possible.
  - 100 layer scattering model. Allows more complicated clouds, developed mostly for comparisons to climate models and GCM's.
- Suggest use of this code for
  - Dust retrievals
  - Cirrus optical depths and particle size
  - Water cloud optical depths (and emissivity for thick clouds)
- Work needed on variability of dust indices of refraction

V6 Scattering RTA: Approach

- Code exists (unless switch to Ping Yang's scattering model), need to find integrator to PGE
- Issues with compile time vs real time selection of scattering tables
- Code gives good agreement with MODIS for dust scattering.
- Retrievals done on single FOV after standard retrieval, could be used to fine-tune the cloud product and add new parameters (cirrus particle size and optical depth).
- Dust retrieval much more mature than scattering cloud retrieval. Dust flag doing a reasonable job of helping us avoid unwanted cloud contamination.

V6 OLR

- UMBC will help produce new AIRS OLR algorithm, maybe in concert with UW.
- Initial algorithm will provide Sussskind's approach but (1) use newer spectroscopy, and (2) may use more spectral channels.
- Development:
  - Start with kCARTA (some development already has begun), then produce fast OLR model.
  - Test versus AER fast OLR model and against existing AIRS OLR model and CERES
- Possibly investigate effect of cirrus on OLR (cirrus has resonance in 400 cm^{-1} region).

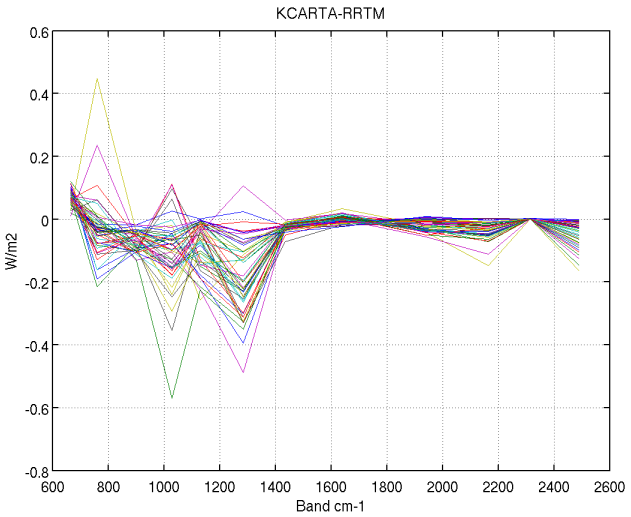
Preliminary work

- Have tested kCARTA (LBL) OLR model
- Tested results for 48 regression profiles against RRTM (from AER group) for bands currently in kCARTA
- $(kCARTA - RRTM) \simeq -0.52 \pm 0.31\ W/m2$
- Plan to extend kCARTA database from existing(605-2830) to (10-3200) cm^{-1}

Preliminary results for 605-2830 cm-1

kCARTA - RRTM

Wavenumbers



Profile